

Assessing Abundance and Diversity of Elasmobranchs in Relation to a Marine Reserve Boundary

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Introduction

- Marine Protected Areas (MPA's) aim to conserve vulnerable species
- Endemic species are at elevated risk of extinction
- South Africa is a hotspot for biodiversity with high endemism for sharks and rays; home to IUCN "Vulnerable" species the smooth hammerhead shark (*Sphyrna zygaena*)

Study Aims

- Examine the efficacy of the De Hoop Nature Reserve (Fig 1) in protecting elasmobranchs
- Analyze abundance and diversity of elasmobranchs inside versus outside reserve boundaries and the effect of habitat



Figure 1. South Africa (inset) and the De Hoop Nature Reserve boundaries.

Methods

- BRUVS were deployed for 60-90 mins at locations inside and outside the reserve on varying substrates
- MaxN is the maximum number of each species seen in one video frame (Fig. 2)
- Frequency of occurrence = BRUVS deployments with species presence/total BRUVS deployments
- Two metrics used to analyze relative abundance: 1) *MaxN per deployment*: sum of the MaxN values of all species per BRUVS deployment, and 2) *MaxN per hour*: MaxN divided by the soak time in hours
- Diversity was total number of species identified per BRUVS deployment
- Abundance and diversity by management type was analyzed with Mann-Whitney U Test
- The effect of habitat on abundance and diversity was tested with a GLM

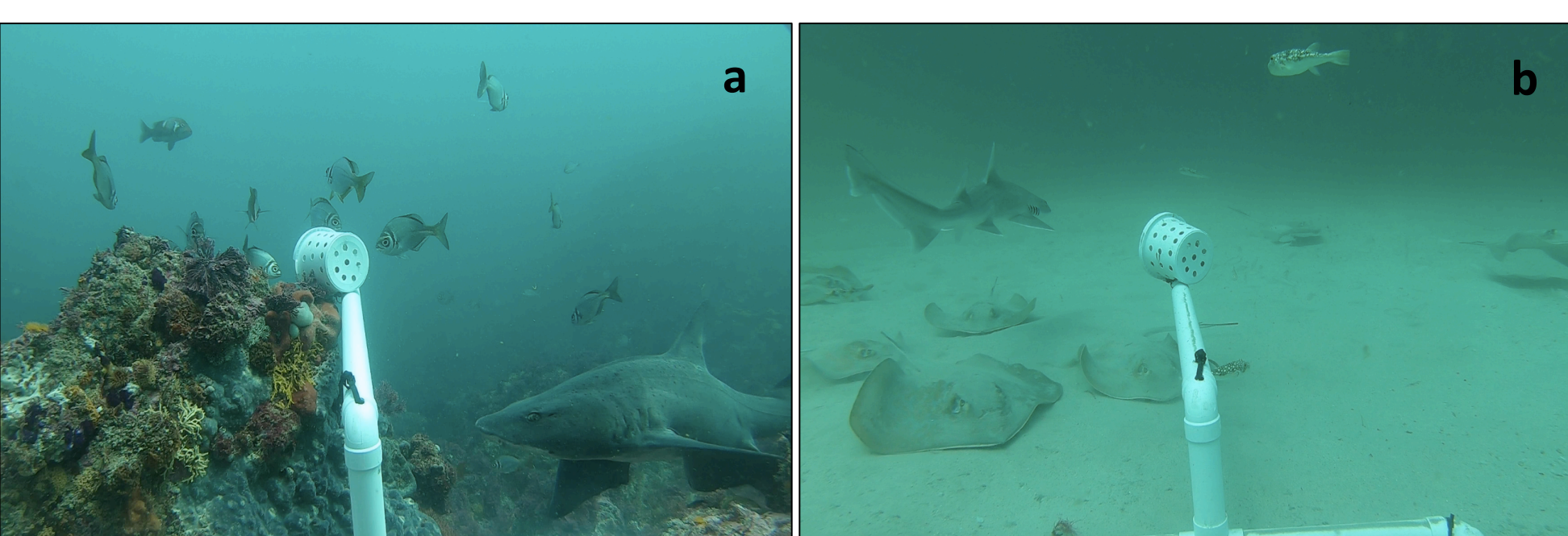


Figure 2. Video frames from BRUVS deployments. a) Seven adult blue stingrays (*Dasyatis pastinaca*), MaxN = 7, one adult smoothhound shark (*Mustelus spp.*), MaxN = 1 on sand. b) One adult spotted gully shark (*Triakis megalopterus*) on reef substrate, MaxN = 1

Results

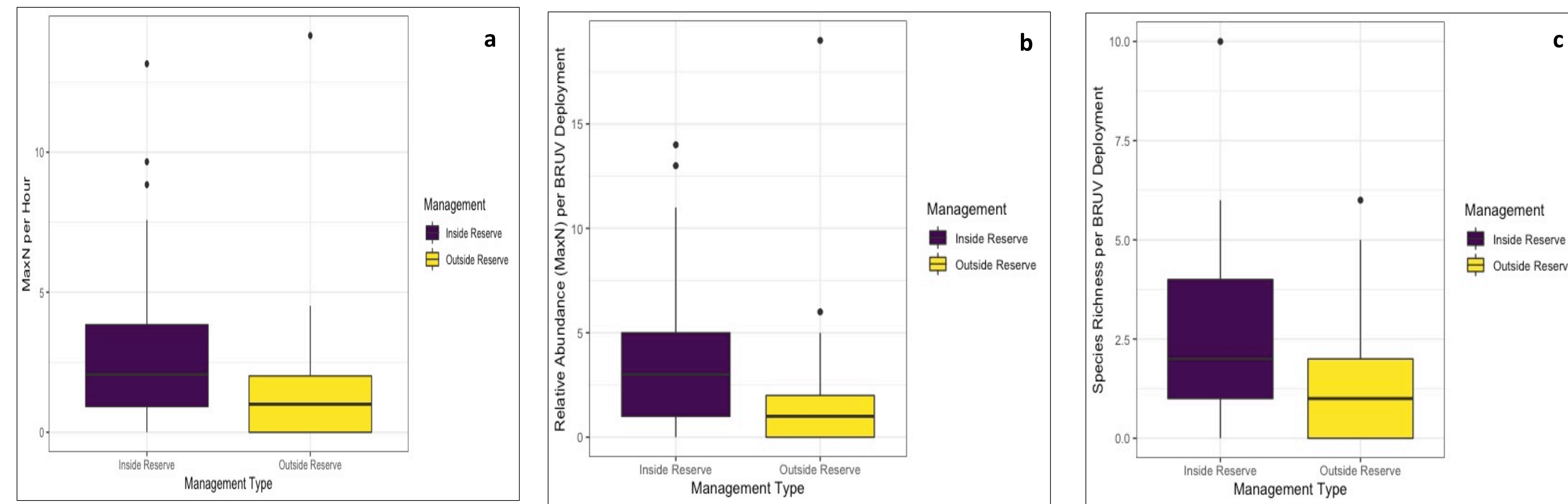


Figure 3. Box plots for relative abundance and diversity for total elasmobranchs by management type. a) MaxN per hour b) MaxN per BRUVS deployment c) Species richness

- Results showed a significantly higher relative abundance of elasmobranchs inside De Hoop compared to outside in terms of MaxN per hour ($p < 0.0003$) and MaxN ($p < 7.58e-5$)
- Results also showed significantly higher diversity inside De Hoop compared to outside ($p < 0.0014$)
- Frequency of occurrence for all elasmobranchs was higher inside the reserve than outside (Table 1)

Table 1. Frequency of occurrence of elasmobranchs by management type

Frequency of Occurrence	Sharks	Rays	Guitarfish	Total Elasmobranchs
Outside Reserve	62.06%	25.86%	1.72%	63.79%
Inside Reserve	80%	35.78%	12.63%	83.15%

- Median MaxN per hour inside the reserve was double that of the outside (Fig. 3a)
- Median MaxN inside the reserve was triple that of the outside (Fig. 3b)
- Median species richness inside the reserve was higher than outside the reserve (Fig. 3c)

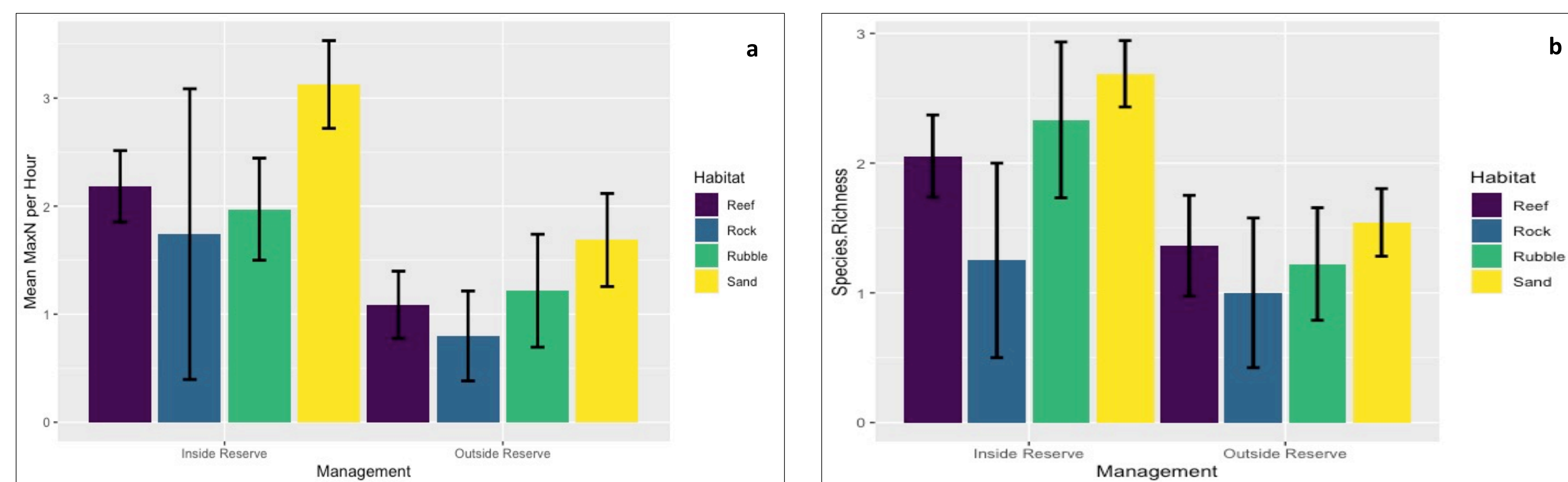


Figure 4. Relative abundance and diversity for total elasmobranchs of management type by habitat. a) MaxN per hour b) Species richness

- For inside the reserve, sand habitat had the highest MaxN per hour, MaxN and species richness (Fig. 4a, 4b).
- Habitat is a significant predictor of MaxN per hour ($p < 0.015$) and MaxN ($p < 0.004$)
- Habitat is not a significant predictor of diversity ($p < 0.162$)
- MaxN per hour was significantly and positively influenced by reef ($p < 2.23e-10$) and sand habitat ($p < 0.0194$)
- MaxN was significantly and positively influenced by reef ($p < 2e-16$) and sand habitat ($p < 0.019$)
- Species richness was significantly and positively influenced by reef habitat ($p < 1.05e-9$)

Discussion

- Rays had high frequency of occurrence in sand habitat most likely due to highly evolved body plan suitable for sand flats
- The pyjama catshark (*Poroderma africanum*) and the spotted gully shark (*Triakis megalopterus*) had high frequency of occurrence in reef habitat most likely due to adaptations for life on a South African reef (i.e. dark coloration, maneuverable fins, etc.)
- Smooth hammerhead sharks were commonly found with smoothhound sharks (*Mustelus spp.*) (Fig. 5) in sand areas outside the reserve where they are exposed to fishing pressure
- In sharing a habitat, there is a high chance that the endangered smooth hammerhead could be caught via bycatch by the longlining smoothhound fishery.
- MPA's benefit elasmobranchs especially within sand and reef habitat
- This study concludes that De Hoop Nature Reserve is effective in protecting elasmobranchs
- This data can be a resource for management implications in De Hoop, and as a model for determining MPA efficacy elsewhere.

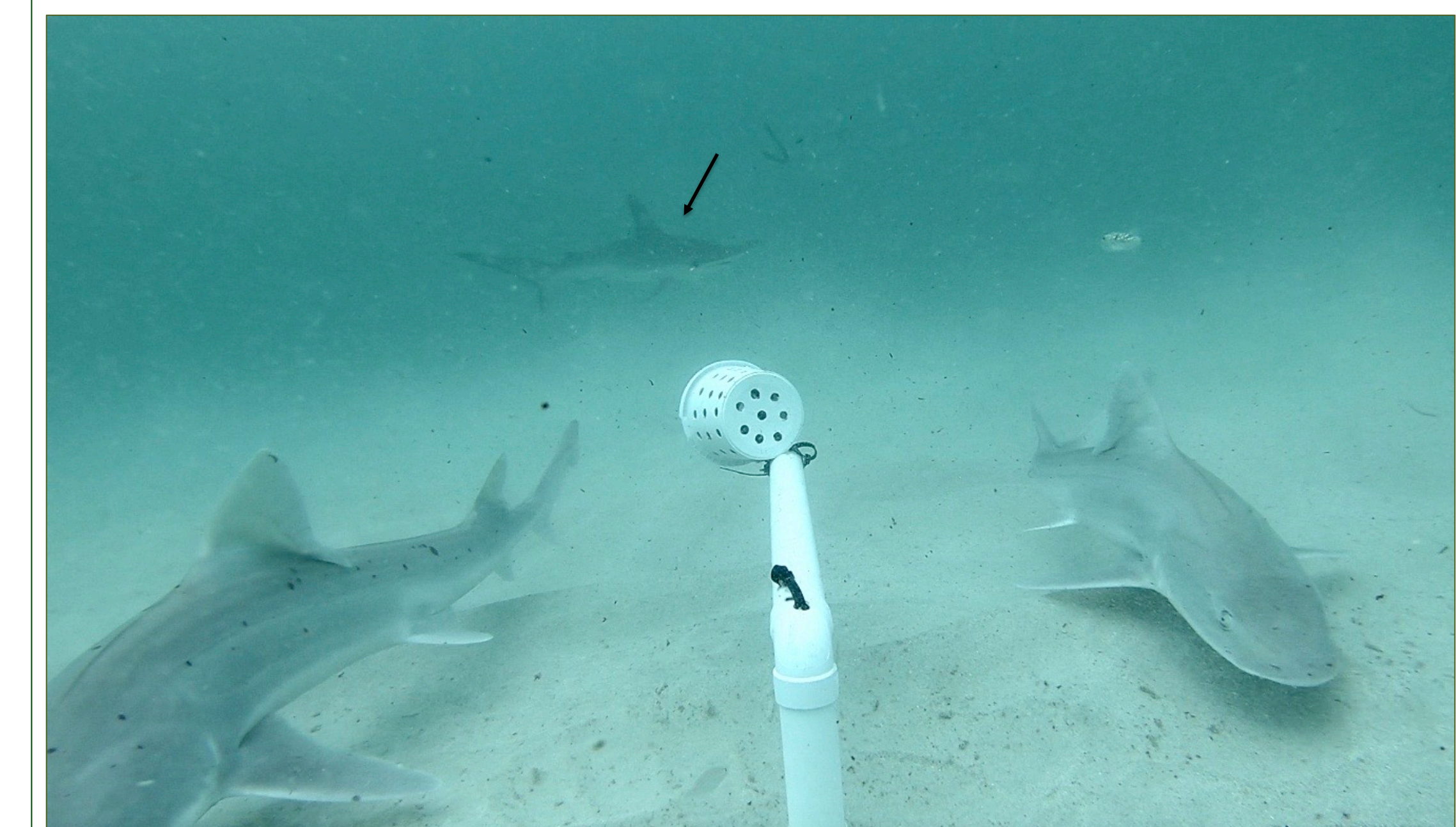


Figure 5. One smooth hammerhead shark (arrow) and two smoothhound sharks on sand habitat outside the boundaries of De Hoop Nature Reserve

Acknowledgments

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